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MAGNETIC COUPLING ARRANGEMENT FOR TRANSMITTING TORQUE

The invention relates to a magnetic coupling arrangement for transmitting torque from an input shaft to an output shaft, whereby at least one magnet arrangement is assigned to the input shaft and to the output shaft, and whereby a containment shell comprising at least one inner sleeve and at least one outer sleeve extends between the magnet arrangements.

Such magnetic coupling arrangements are used for the contact-free transmission of forces, e.g., between two hermetically sealed separate spaces, which are coupled by magnetic fields alone without any additional mechanical connections. The magnetic couplings may be used with magnetic pumps or the like, for example. In addition, such coupling systems may be used for agitators, blowers, mixers, centrifuges or similarly moving apparatuses.

The containment shell of such magnetic couplings can be manufactured, for example, of non-metallic materials such as ceramics, carbon fiber composites or synthetics.

Such containment shells do not have any eddy current losses, however, the use of these containment shells is significantly limited due to the rising pressures and temperatures. In

addition, all-metal containment shells are known. Due to moving magnetic fields, high eddy currents arise in metallic containment shells, requiring additional drive loads, which is reflected in the form of heat in the magnetic space.

The eddy currents increase as the transfer performance, the containment shell wall thickness and/or the circumferential speed of the magnetic coupling increases, such that the efficiency of, for example, magnetic couplings with a metallic containment shell is influenced negatively. Furthermore, magnetic coupling arrangements are known that exhibit a containment shell with a so-called sandwich design.

Such a containment shell is known from the German Patent No. 689 15 713. This patent discloses a low-loss, synchronous, magnetic drive system that comprises a magnetic coupling arrangement, whereby the magnetic coupling exhibits a containment shell comprising an inner sleeve and an outer sleeve. With the known drive system, the inner sleeve is designed with numerous parallel core laminations or ring elements, respectively.

This has the disadvantage of requiring numerous components for the inner sleeve. In addition to increased manufacturing and assembly costs, another disadvantage is that the individual core laminates must be aligned to each other during assembly.

A relatively large portion of the volume of the part of the cylinder that is pressurized and to some degree exposed to aggressive media is not made of metal but of flat gasket material.

Furthermore, various elastomers are necessary for sealing the pressure cylinder with said elastomers being located in the product space just as the spring component. The outer body does not form an additional sealed protective sleeve. In addition, maintenance costs for a containment shell designed in this manner are relatively high because disassembly and reassembly of the containment shell is time-consuming due to the many components.

It is the objective of the invention at hand to propose a magnetic coupling arrangement of the type described above that essentially exhibits a high efficiency and is designed in an assembly and maintenance-friendly manner and exhibits maximum operational reliability.

This objective is achieved by the features of patent claim 1. Additional advantageous embodiments become apparent in particular from the sub-claims.

Proposed is a magnetic coupling arrangement for transmitting torque from an input shaft to an output shaft, whereby at least one magnet arrangement is assigned to the input shaft and to the output shaft, and whereby a containment shell comprising at least one inner sleeve and at least one outer sleeve extends between the magnet arrangements. According to the invention, the inner sleeve can be formed from at least one profile element or the like that extends approximately in the manner of a coil and the outer sleeve can be provided for axially fastening the profile element.

In this manner, the inner sleeve of the containment shell can be made of one component that is wound in the manner of a coil like a helical spring of continuous material such that the manufacturing costs and the maintenance costs of the coupling arrangement subject to the invention are reduced significantly. By selecting the number of windings and by specifying the winding radius, various dimensions of containment shells can be realized, preferably of the same continuous profile, corresponding to the application. Materials that can be used are, for example, alloys such as the 1.4571 or 2.4610 alloy.

Overall, the magnetic coupling arrangement subject to the invention results in low-loss containment shells with a very compact design, where the eddy current losses are reduced when

compared to full-metal containment shells and the function of the magnetic coupling can be used efficiently.

Within the scope of one advantageous embodiment of the present invention, it may be provided that the profile element that extends in the manner of a coil or of a helical spring exhibits at least on a first side a groove or the like and on a second side, which is oriented parallel to said first side, exhibits at least one protrusion or the like that is fitted to said groove, such that the protrusion and the groove of adjacent windings of the profile element that is arranged in the manner of a coil are engaged in each other. In this manner, a groove and tongue connection can be realized that enables a chambered sealing arrangement and simultaneously realizes a centering of the shifting windings of the profile element to each other.

However, other design shapes for the profile element used for connecting purposes, such as round or double grooves or smooth connections are imaginable as well. In addition to the shapes mentioned, other profile shapes are also possible. For example, flat rectangular profiles, round profiles, double-groove profiles, hollow profiles or the like can be imagined. When using hollow profiles, it is possible to provide one profile each for the feed and the return such that heating or cooling of the containment shell can be realized.

To achieve optimum sealing between the individual windings of the profile element, it can be provided according to another embodiment of the invention that a sealing material is provided preferably between the two contacting sides of different windings of the profile element. Particularly advantageous is the use of continuous goods such as a sealing tape, a sealing cord, a sealing compound or the like. In this manner, the inner sleeve of the magnetic coupling arrangement subject to the invention offers an autonomous hermetically sealed pressure sleeve. However, a coating can be imagined for sealing purposes as well.

According to another development of the invention, it may be provided that the outer sleeve exhibits an approximately cylindrical jacket with an approximately circular bottom.

The bottom is attached to the jacket. For example, the bottom may be welded to the jacket. However, detachable attachment means can be imagined as well. The other end of the jacket is attached to a flange directly connected to the housing. Here too, a detachable and a non-detachable manner of fastening can be selected. In this manner, the outer sleeve forms a second hermetical seal such that no medium can escape even if a leak develops at the inner sleeve. Suitable sensors can be provided to monitor a degree of tightness.

To further reduce eddy current losses, the jacket of the outer sleeve may be designed with slots in certain sections according to another variation of the invention. The pressure stability of the outer sleeve can be increased if no continuous slots running in the longitudinal direction of the jacket are used. It can also be imagined that the jacket is only notched in sections in the longitudinal direction. With this design, it may be provided for further reduction of the occurring eddy currents that at least one hole is introduced in the notches. Preferably, the notches can be perforated in any manner. The notches and the perforation can be introduced by etching or laser technology, for example.

To seal a notched or slotted sleeve as well, it may be provided that the slots, the notches and/or the perforation are sealed appropriately. Preferably, the outer and/or the inner side of the jacket of the outer sleeve can be sealed using a film of, for example, PTFE or another material. This material may be, for example, a synthetic resin, a fiber composite material, also an applied ceramic material, or the like. In this manner, an escape of the product can also be prevented through the outer sleeve.

It has proven to be advantageous if a solid support ring remains at the jacket between the notches and/or slotted sections of the jacket in the direction of the circumference. This makes the

outer sleeve even less sensitive to pressure loads. The efficiency of the coupling arrangement subject to the invention can be further improved through recesses in the magnet arrangements.

For axial fastening of the inner sleeve to a flange that is directly connected to the housing, for example, of a pump or the like, it may be provided that the bottom of the outer sleeve compresses the windings of the profile element in axial direction such that the profile element is fastened to the flange on the housing. Preferably, it can be provided that the end sections of the outer sleeve and of the inner sleeve facing the flange are fastened to said flange. For example, the end sections may be welded to the flange or fastened to it in a detachable manner.

In order to achieve a suitable initial tension of the inner sleeve versus the flange, it can be provided according to an additional embodiment of the present invention that a spring-loaded connection is provided between the inner sleeve and the outer sleeve. Each suitable component can be designed spring-loaded. For example, the bottom of the outer sleeve can be designed as a spring plate. It is also possible to design the material and structure of a fixed abutment element and the adjacent components such as the sleeves, the bottoms and/or the

profile elements such that the spring force necessary for reliable sealing is applied.

Another possible variation of the invention may provide that at least one spring element is located between the bottom of the inner sleeve and the bottom of the outer sleeve. A sufficient initial tensioning force may be applied during assembly of the inner sleeve for the axial fastening via the spring element, which may be a disc spring or the like, for example. The spring element may also be realized at the flange component, for example.

An additional variation of the present invention may propose a certain design of the magnet arrangement, in particular at the magnetic coupling arrangement subject to the invention but also at other magnetic couplings. Preferably, each magnet arrangement can exhibit magnets with different polarities. The outer magnet arrangement can be fastened to the input shaft and the inner magnet arrangement to the output shaft. Preferably, the magnet arrangements are designed in the shape of a ring and are protected from mechanical and chemical stress. However, other structural designs of the magnet arrangement are possible as well.

Every magnet arrangement can exhibit at least one magnet ring, which exhibits in the radial direction at least one alternating polarization N, S. Several magnet rings can form one group, whereby the magnet rings of each group in general exhibit the same polarity in the longitudinal direction. The magnet rings of one group can be arranged preferably with or without gaps. Other polarization directions are imaginable as well. For example, each magnet ring may only exhibit one pole N, S in the radial direction.

According to an additional development, it can be provided that each magnet arrangement exhibits several groups each with different polarizations in relation to each other and arranged in succession in the longitudinal direction. A gap can be provided between the individual groups. However, it is also possible to arrange the groups without gap in the longitudinal direction.

The efficiency of the magnetic coupling arrangement subject to the invention can be further increased if the spaces between the various groups are assigned in the longitudinal direction in the area of the support rings at the jacket.

According to another development of the present invention, it can be provided that the respective magnet arrangements are

oriented towards each other at the outer sleeve and the inner sleeve such that each time magnets with different polarization are opposite to one another. However, other arrangement options can be imagined as well.

Following, the present invention is described based on the enclosed drawing of which

Figure 1 shows a section of a partial view of a possible embodiment of a magnetic coupling arrangement subject to the invention;

Figure 2 shows a section of a partial view along the lines A-A of Figure 1;

Figure 3 shows a cross-sectional view of a profile element of the magnetic coupling arrangement subject to the invention;

Figure 4 shows a schematic partial view of an outer sleeve of the magnetic coupling arrangement subject to the invention; and

Figure 5 shows a section of a partial view of a containment shell with a magnet arrangement in an input and an output system.

Figure 1 shows a possible embodiment of a magnetic coupling arrangement subject to the invention for transmitting torque

from an input shaft 1 to an output shaft 2 of an otherwise not shown apparatus.

With the magnetic coupling arrangement subject to the invention, an outer magnet arrangement 3 is provided at the input shaft 1 and an inner magnet arrangement 4 at the output shaft 2.

The outer magnet arrangement 3 and the inner magnet arrangement 4 each exhibit different magnets with different polarities and the polarity of each magnet is designated by the letters N (north pole) and S (south pole). The outer and inner magnet arrangement 3,4 of the shown variation of the magnetic coupling arrangement each shows three groups of magnet rings 19, whereby the magnet rings 19 of a group always exhibit the same orientation of the polarity. An alternating polarity N, S in the radial direction can be provided for each magnet ring 19.

The magnet arrangements 3,4 each exhibit a first group with two magnet rings 19, a second group with four magnet rings 19 and finally a third group again with two magnet rings 19, as is apparent especially from Figures 1 and 2.

A containment shell 5 comprising an inner sleeve and an outer sleeve extends between the two magnet arrangements 3,4. With this exemplary embodiment, the outer sleeve is welded with its

one end at a flange that is directly connected to the housing and with the other end at the bottom 12. A different variation provides that a detachable elastic connection is provided at the flange 6 and/or at the bottom 12. The inner sleeve is designed plane at the ends and contacts the flange 6 and the bottom 17 via a sealing compound.

According to the invention, at the magnetic coupling arrangement, the inner sleeve is formed of a profile element 7 that extends in the manner of a coil. The profile element 7 exhibits at the end that points away from the flange 6 a bottom 17 that is fastened to the end of the profile element 7 and is sealed. The outer sleeve is used for axial fastening and radial support of the profile element 7, with details of the design and the type of fastening of the respective components of the proposed magnetic coupling arrangement being presented in Figures 2 to 5.

Figure 2 shows a sectional view along the line A-A of Figure 1. Double-arrows indicate the respective possible rotational movements of the input shaft 1 and the output shaft 2, whereby the input shaft 1 functions as a driving magnet cup and the output shaft 2 as a driven rotor.

Figure 3 shows a magnified cross-sectional view of the profile element 7 that is used as the inner sleeve. A tongue and groove

connection is provided to connect the individual windings 18 of the profile element 7 that extends in the manner of a coil to one another. For this purpose, the profile element 7 exhibits on a first side a groove 8 with an approximate trapezoidal cross-section. At a second side that is oriented parallel to the first side, a protrusion 9 is provided that is fitted to the groove 8, such that the protrusion 9 and the groove 8 of adjacent windings 18 can engage in one another. To achieve a seal between the groove 8 and the protrusion 9, a sealing material 10, such as a sealing tape, a sealing cord liquid material, direct coating material or a jacket may be provided in the groove 8.

Figure 4 is a magnified partial view of the outer sleeve. The outer sleeve exhibits an approximately cylindrical jacket 11 with an approximately circular bottom 12. Notches 13 are introduced in the cylindrical jacket 11 in the longitudinal direction of the outer sleeve, whereby at the shown embodiment the notches 13 are only introduced in sections, such that support rings 14 with a greater wall thickness remain between the notches 13, which is shown particularly in Figure 5. The support rings 14 give the jacket 11 a high pressure resistance. As can be seen in Figure 4, the notches 13 can be perforated in that the remaining wall thickness is reduced by holes 15 in the longitudinal direction of the notches 13. To improve operational

reliability, the holes 15, the notches and/or the slots can be sealed. The sealing (not shown) can be provided on the inside and on the outside of the jacket 11.

Figure 5 shows a magnified partial view of the containment shell 5 of the magnetic coupling arrangement subject to the invention between the outer magnet arrangement 3 and the inner magnet arrangement 4. This Figure shows in particular that at the shown exemplary embodiment of the magnetic coupling arrangement subject to the invention, the magnets of the respective magnet arrangement 3,4 are at a particular distance to one another such that no magnet is provided in the area of the support ring 14. In addition, magnets of the outer and of the inner magnet arrangements 3,4 with different polarities (N, S) are located opposite to one another.

For the assembly of the inner and the outer sleeve, initially the profile element 7 together with the outer sleeve is fastened to the flange 6 on the sealing compound 20. Thereafter, the spring element 16 is compressed between the bottom 17 of the profile element 7 and the bottom 12 of the jacket 11. Finally, the jacket 11 is fastened to the bottom 12.

Reference number list

1 Input shaft

2 Output shaft

3 Outer magnet arrangement

4 Inner magnet arrangement

5 Containment shell

6 Flange

7 Profile element

8 Groove

9 Protrusion

10 Sealing material

11 Jacket

12 Bottom

13 Notch

14 Support ring

15 Hole

16 Spring element

17 Bottom

18 Windings

19 Magnet ring

20 Sealing compound